COMMERCIAL ELECTRO-OPTICAL (EO) SUPPORT DATA EXTENSIONS (SDE)

for the National Imagery Transmission Format (NITF)
for the National Imagery Transmission Format Standard (NITFS)

Version 0.9
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1. DETAILED REQUIREMENTS

1.1 Generic Tagged Extension Mechanism. The tagged record extensions defined in this document are "controlled tagged record extensions" as defined in Section 5.9 of the NITF 2.0 document. The tagged record extension format is summarized here for ease of reference. Tables 1.1-1 and 1.1-2 describe the general format of a controlled tagged record extension. NOTE: All blanks or spaces in this document are defined as ASCII spaces (i.e. hex '20') and are used interchangeably.

Table 1.1-1 Controlled Tagged Record Extension Format

(R) = required and (C) = conditional

FIELD	NAME	SIZE	VALUE RANGE	TYPE
CETAG	Unique extension type identifier	6	Alphanumeric	R
CEL	Length of CEDATA field	5	00001 to 99985	R
CEDATA	User-defined data	*	User-defined	R

* equal to value of CEL field.

All fields of all of the tags defined within this document are of type "Required".

Table 1.1-2 Controlled Tagged Record Extension Field Descriptions

FIELD	VALUE DEFINITIONS AND CONSTRAINTS
CETAG	This field shall contain a valid alphanumeric identifier properly registered with the NTB.
CEL	This field shall contain the length in bytes of the data contained in CEDATA. The tagged record's length is 11+ the value of CEL.
CEDATA	This field shall contain data of either binary or character data types defined by and formatted according to user specification. The length of this field shall not cause any other NITF field length limits to be exceeded but is otherwise fully user-defined.

The CETAG and CEL fields essentially form a small (11 byte) tagged record subheader. The format and meaning of the data within the CEDATA field is the subject of this document for several, individual controlled tagged record extensions.

Multiple tagged extensions can exist within the tagged record extension area. There are several such areas, each of which can contain up to 99,999 bytes worth of tagged extensions. There is also an overflow mechanism, should the sum of all tags in an area exceed 99,999 bytes. The overflow mechanism allows for up to 1 Gbyte of tags. Figure 1.1-1 shows a diagram of the tagged extension locations within the NITF 2.0 file structure.

While the extensions defined in this document will typically be found in the **image sub-header**, it is possible that they could appear in a Data Extension Segment which is being used as an overflow of the image sub-header.

FYI ONLY

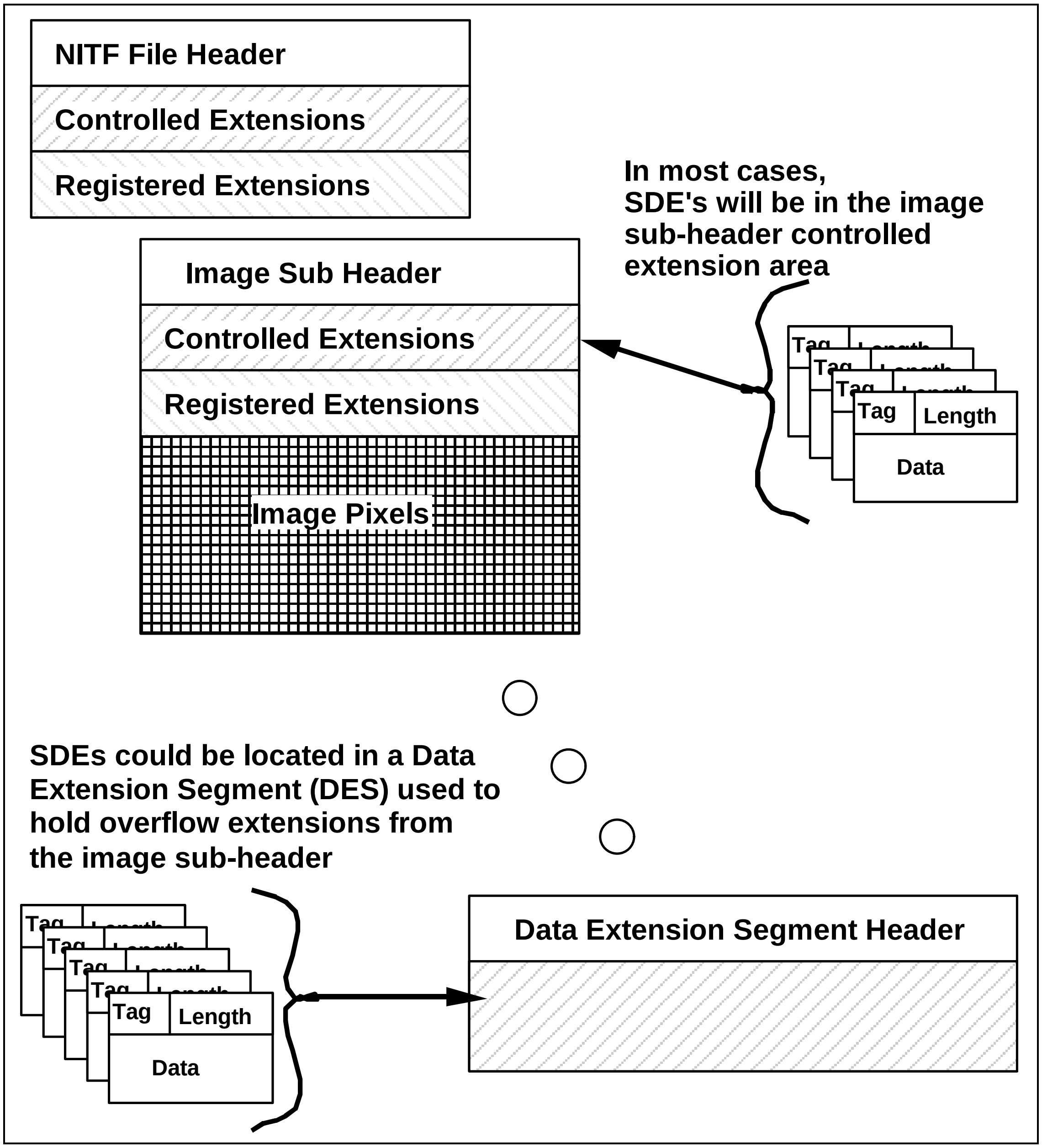

Figure 1.1-1. ***Support Data Extensions (SDEs) may be located in these areas***

If the information contained within an extension is not available, the extension will not be present in the file. For example, many images may not contain an STREOB. If the intended use of a file does not require the information contained in an extension, it is not required to be present. The set of extensions stored within the file can change over the lifetime of the image. For example, the RPC00A tag may be added to the file at some time after the NITF 2.0 file is initially created, or additional STREOB extensions could be added as stereo mates are identified. When an extension is present, all of the information listed as Required must be filled in.

FYI ONLY

2.1 <u>STDIDC - Standard ID</u>. The Standard ID extension contains image identification data which supplements the image subheader. Some parameters in this extension may be used by USIGS compliant systems. The format and description for the user defined fields of the STDIDC extension are detailed in Table 2.1-1 A single STDID is placed in the Image Subheader; where several images relate to a single scene, an STDIDC may be placed in each applicable Image Subheader. Note: The fields ACQUISITION_DATE through END_ROW constitute an Image ID which is used by other SDEs (e.g., STREOB) to designate unique images for associating imagery pairs or sets.

Table 2.1-1. <u>STDIDC - Standard ID Extension Format</u>

(TYPE "R" = Required, "C" = Conditional, < > = null data allowed)

FIELD	NAME	SIZE	VALUE RANGE	UNITS	TYPE
CETAG	Unique Extension Identifier	6	STDIDC	n/a	R
CEL	Length of Data Field	5	00089	Bytes	R
The following fields define STDIDC					
ACQUISITION_DATE	<u>Acquisition Date</u>. This field shall contain the date of the collection mission (date of aircraft takeoff) in the format YYYYMMDDHHMMSS, in which YYYY is the year, MM is the month (01–12), DD is the day of the month (01-31), HH is the hour (0-23), MM is the minute (0-59) and SS (00-59) is the second (00-59). The date changes at midnight UTC. This field is equivalent to the IDATIM field in the image sub-header.	14	YYYYMMDD HHMMSS		R
MISSION	<u>Mission Identification</u>. Fourteen character descriptor of the vehicle. For satellite, identifies the specific vehicle as source of image data. For aerial, identifies the scanner.	14	Alphanumeric Valid values as per list maintained by JITC		R
PASS	<u>Pass Number</u>. Each pass or flight per day shall be identified by a number in the range 01 to 99. In order to ensure uniqueness in the image id, if the satellite or aerial mission extends across midnight UTC, the pass number shall be 01 through 99 on images acquired before midnight UTC and Ax on images acquired after midnight UTC; for extended missions Bx, … Zx shall designate images acquired on subsequent days (where x is in the range of 0 to 9).	2	Alphanumeric 01 to 99, A1 to A9 B1 to B9 … Z1 to Z9		R
OP_NUM	<u>Image Operation Number</u>. Imaging operations numbers shall increase within each Imaging System pass. A value of "000" indicates that the system does not number imaging operations. For video systems, this field will contain the frame number within the acquisition date and time.	3	000 to 999		R

Table 2.1-1. STDIDC — Standard ID Extension Format Continued.

FIELD	NAME	SIZE	VALUE RANGE	UNITS	TYPE
START_SEGMENT	Start Segment ID Identifies images as separate pieces (segments) within an imaging operation. AA is first segment, AB is second segment, etc...	2	AA to ZZ		R
REPRO_NUM	Reprocess Number This field indicates whether the data was reprocessed to overcome initial processing failures, or has been enhanced. A "00" in this field indicates that the data is an originally processed image, "01" indicates the first reprocess/enhancement, etc...	2	00 to 99		R
REPLAY_REGEN	Replay (remapping) imagery mode shall provide the capability to alter the digital processing of previously recorded digital imagery. Regen regeneration imagery mode provides the capability to produce an image identical to the image that was produced in initial process. The images are used as replacements for images damaged during production A "000" in this field indicates that the data is an originally processed image.	3	Alphanumeric		R
BLANK_FILL	Blank Fill	1	blank or _		<R>
START_COLUMN	Starting Column Block- For tiled (blocked) sub-images, the starting column block is defined as the offset, in blocks, of the first block in the cross-scan direction relative to start of the original reference image tiling.	3	001 to 999		R
START_ROW	Starting Row Block- For tiled (blocked) sub-images, the starting row block is defined as the offset, in blocks, of the first block in the along-scan direction relative to start of the original reference image tiling.	5	00001 to 99999		R
END_SEGMENT	Ending Segment ID of this file	2	AA to ZZ		R
END_COLUMN	Ending Column Block- For tiled (blocked) sub-images, the ending column block is defined as the offset, in blocks, of the last block of the image in the cross-scan direction relative to start of the original reference image tiling.	3	001 to 999		R

Table 2.1-1. STDIDC — Standard ID Extension Format Continued.

FIELD	NAME	SIZE	VALUE RANGE	UNITS	TYPE
END_ROW	Ending Row Block - For tiled (blocked) sub-images, the ending row block is defined as the offset, in blocks, of the last block in the along-scan direction relative to start of the original reference image tiling.	5	00001 to 99999		R
COUNTRY	Country Code. Two letter code defining the country for the reference point of the image. Standard codes may be found in FIPS PUB 10-4.	2	AA to ZZ		<R>
WAC	World Aeronautical Chart - 4 number World Aeronautical Chart for the reference point of the image segment. World Aeronautical Chart grids the earth into regions with a 4 number ID.	4	0001 to 1866		<R>
LOCATION	Location - the natural reference point of the sensor; provides a rough indication of geographic coverage. The format DDMMX represents degrees (00-89) and minutes (00-59) of latitude, with X = N or S for north or south, and DDMMY represents degrees (000-179) and minutes (00-59) of longitude, with Y = E or W for east or west, respectively. For SAR imagery, the reference point is normally the center of the first image block. For EO-IR imagery, the reference point for framing sensors is the center of the frame; for continuous sensors, it is the center of the first line.	11	DDMMXDDDMMY		R
	reserved	5	spaces		<R>
	reserved	8	spaces		<R>

2.2 USE00A - Exploitation Usability. The Exploitation Usability extension is intended to allow a user program to determine if the image is usable for the exploitation problem currently being performed. It also contains some catalogue metadata. The format and descriptions for the user defined fields of the USE00A are detailed in Table 2.2-1.

Table 2.2-1 USE00A - Exploitation Usability Extension Format
(TYPE "R" = Required, "C" = Conditional, < > = null data allowed)

FIELD	NAME	SIZE	VALUE RANGE	UNITS	TYPE
CETAG	Unique Extension Identifier	6	USE00A	n/a	R
CEL	Length Data Fields	5	00107	Bytes	R
The following fields define USE00A					
ANGLE_TO_NORTH	Angle to True North, measured clockwise from first row of the image.	3	000 to 359	degrees	R
MEAN_GSD	Mean Ground Sample Distance. The geometric mean of the cross and along scan center-to-center distance between contiguous ground samples. Accuracy = ±10% Note: Systems requiring an extended range shall insert a default value of "000.0" for this field and utilize the PIAMC tag.	5	000.0 to 999.9	inches	R
	reserved	1	spaces		<R>
DYNAMIC_RANGE	Dynamic range of pixels in image	5	00000 to 99999		<R>
	reserved	3	spaces		<R>
	reserved	1	spaces		<R>
	reserved	3	spaces		<R>
OBL_ANG	Obliquity Angle	5	00.00 to 90.00	degrees	<R>
ROLL_ANG	Roll Angle	6	±90.00	degrees	<R>
	reserved	12	spaces		<R>
	reserved	15	spaces		<R>
	reserved	4	spaces		<R>
	reserved	1	space		<R>
	reserved	3	spaces		<R>
	reserved	1	spaces		<R>
	reserved	1	space		<R>
N_REF	Number of Reference Lines Number of reference lines in the image. For each reference line, there will be a REFLNA extension in the NITF file.	2	00 to 99		R
REV_NUM	Revolution Number The revolution number in effect at the northernmost point of orbit.	5	00001 to 99999		R
N_SEG	Number of Segments	3	001 to 999		R

Table 2.2-1 USE00A - Exploitation Usability Extension Format - Continued.

FIELD	NAME	SIZE	VALUE RANGE	UNITS	TYPE
MAX_LP_SEG	Maximum number of lines per segment, including overlap lines. The maximum number of lines per segment depends upon the aggregation mode of the collector.	6	000001 to 999999		<R>
	Reserved	6	Spaces		R
	Reserved	6	Spaces		R
SUN_EL	Sun Elevation in degrees measured from the target plane at intersection of the optical line of sight with the earth's surface at the time of the first image line. Default value, if data is not available, is 999.9.	5	-90.0 to +90.0, or 999.9	degrees	R
SUN_AZ	Sun Azimuth in degrees measured from true North clockwise (as viewed from space) at the time of the first image line. Default value, if data is not available, is 999.9.	5	000.0 to 359.0, or 999.9	degrees	R

2.3 STREOB - Stereo Information The STREO extension provides links between several images that form a stereo set to allow exploitation of elevation information. There can be up to 3 STREO extensions per image. The format and descriptions for the User Defined fields of the STREOB extension is detailed in Table 2.3-1. The Stereo geometry definitions for Bisector Elevation Angle (BIE), convergence angle and asymmetry angle are specified in paragraph 2.3.1.

Table 2.3-1. STREOB - Stereo Information Extension Format
(TYPE "R" = Required, "C" = Conditional, < > = null data allowed)

FIELD	NAME	SIZE	VALUE RANGE	UNITS	TYPE
CETAG	Unique Extension Identifier	6	STREOB	n/a	R
CEL	Length of Data Field	5	00094	Bytes	R
The Following Fields Define STREOB :					
ST_ID	Stereo Mate. The image ID of the first stereo mate. The fields ACQUISITION_DATE through END_ROW in the STDIDC tag constitutes the image ID.	60	Alphanumeric	n/a	R
N_MATES	Number of Stereo Mates. If there are no stereo mates, there will not be any STREOB (TBR) extensions in the file. If there is a STREOB (TBR) extension, then there will be at least 1 stereo mate.	1	1 to 3	n/a	R
MATE_INSTANCE	Mate Instance identifies which stereo mate is described in that extension. For example, this field contains a 2 for the second stereo mate.	1	1 to 3	n/a	R
B_CONV	Beginning Convergence Angle, defined at the first lines of the fore/left and aft/right images, unless those images are more than 90 degrees apart. If the images are more than 90 degrees apart, the first line of the fore and the last line of the aft shall be used.	5	00.00 to 90.00	degrees	<R>
E_CONV	Ending Convergence Angle, defined at the last lines of the fore/left and aft/right images, unless those images are more than 90 degrees apart. If the images are more than 90 degrees apart, the last line of the fore and the first line of the aft shall be used.	5	00.00 to 90.00	degrees	<R>
B_ASYM	Beginning Asymmetry Angle, defined at the first lines of the fore/left and aft/right images, unless those images are more than 90 degrees apart. If the images are more than 90 degrees apart, the first line of the fore and the last line of the aft shall be used.	5	00.00 to 90.00	degrees	<R>

Table 2.3-1. STREOB - Stereo Information Extension Format - Continued.

FIELD	NAME	SIZE	VALUE RANGE	UNITS	TYPE
E_ASYM	Ending Asymmetry Angle, defined at the last lines of the fore/left and aft/right images, unless those images are more than 90 degrees apart. If the images are more than 90 degrees apart, the last line of the fore and the first line of the aft shall be used.	5	00.00 to 90.00	degrees	<R>
B_BIE	Beginning BIE less Convergence Angle of Stereo Mate, defined at the first lines of the fore/left and aft/right images, unless those images are more than 90 degrees apart. If the images are more than 90 degrees apart, the first line of the fore and the last line of the aft shall be used.	6	$\pm$ 90.00	degrees	<R>
E_BIE	Ending BIE less Convergence Angle of Stereo Mate, defined at the last lines of the fore/left and aft/right images, unless those images are more than 90 degrees apart. If the images are more than 90 degrees apart, the last line of the fore and the first line of the aft shall be used.	6	$\pm$ 90.00	degrees	<R>

2.3.1 Stereo Geometry Definitions Refer to Figure 2.3-1. Stereo geometry is often described in terms of convergence angle and asymmetry angle at a ground point defined by radius vector $\overline{R}$. These angles are measured in the plane formed by the two lines of sight (one for each image) to the ground point. Given the geocentric radius vectors to the sensor's principle point for the two images, $\overline{R}_{01}$ and $\overline{R}_{02}$, the two line of sight vectors to the ground point are given by:

$$\overline{L}_1 = \overline{R} - \overline{R}_{01}$$

$$\overline{L}_2 = \overline{R} - \overline{R}_{02}$$

where all of the above vectors are defined in the S_E coordinate system.

Let:

$$\hat{q}_1 = -\overline{L}_1 \ / \ |\overline{L}_1|$$

$$\hat{q}_2 = -\overline{L}_2 \ / \ |\overline{L}_2|$$

The convergence angle, C, is the angle between $\hat{q}_1$ and $\hat{q}_2$ and is given by:

$$C = \cos^{-1}(\hat{q}_1 \bullet \hat{q}_2), \quad 0 \le C \le p$$

The asymmetry angle, ♠3, at a ground point is the angle between the projection of $\hat{Z}_T$ into the plane of the convergence angle and the bisector, B, of the convergence angle. $\hat{Z}_T$ is the ground geocentric "up" and is defined by geocentric radius vector $\overline{R}$,

$$\hat{Z}_T = \overline{R} \; / \; \left|\overline{R}\right|$$

Define vector $\hat{\mathrm{A}}$ perpendicular to the plane of the convergence defined by vectors $\hat{q}_1$ and $\hat{q}_2$. Then:

$$\hat{\mathrm{A}} = \left(\hat{q}_1 \times \hat{q}_2\right) / \left|\hat{q}_1 \times \hat{q}_2\right|$$

The unit vector along the projection of $\hat{Z}_T$ into the plane of the convergence, $\hat{Z}'_T$ is given by:

$$\hat{Z}'_T = \hat{A} \times \left(\hat{Z}_T \times \hat{A}\right) / \left|\hat{A} \times \left(\hat{Z}_T \times \hat{A}\right)\right|$$

The unit vector along the bisector, B, of the convergence angle (the angle between $\hat{q}_1$ and $\hat{q}_2$) is given by:

$$\hat{B} = \left(\hat{q}_1 + \hat{q}_2\right) / \left|\hat{q}_1 + \hat{q}_2\right|$$

The asymmetry angle is computed by:

$$\Delta\Sigma = \cos^{-1}\left(\hat{\mathrm{B}} \bullet \hat{\mathrm{Z}}'_T\right), \quad 0 \le \Delta\Sigma \le p \, / 2$$

If $\hat{\mathrm{Z}}'_T$ lies in the positive Along-Track (A/T) direction from $\hat{\mathrm{B}}$,

$$\hat{\mathrm{A}} \bullet \left(\hat{\mathrm{Z}}'_T \times \hat{\mathrm{B}}\right) < 0$$

Note that Figure 2.3-1 shows $\hat{Z}'_T$ in the minus A/T direction from $\hat{\mathrm{B}}$. The elevation angle of the bisector of the Stereo Convergence Angle, BIE is given by:

$$\mathrm{BIE} = \sin^{-1}\left(\hat{\mathrm{Z}}_T \bullet \hat{\mathrm{B}}\right)$$

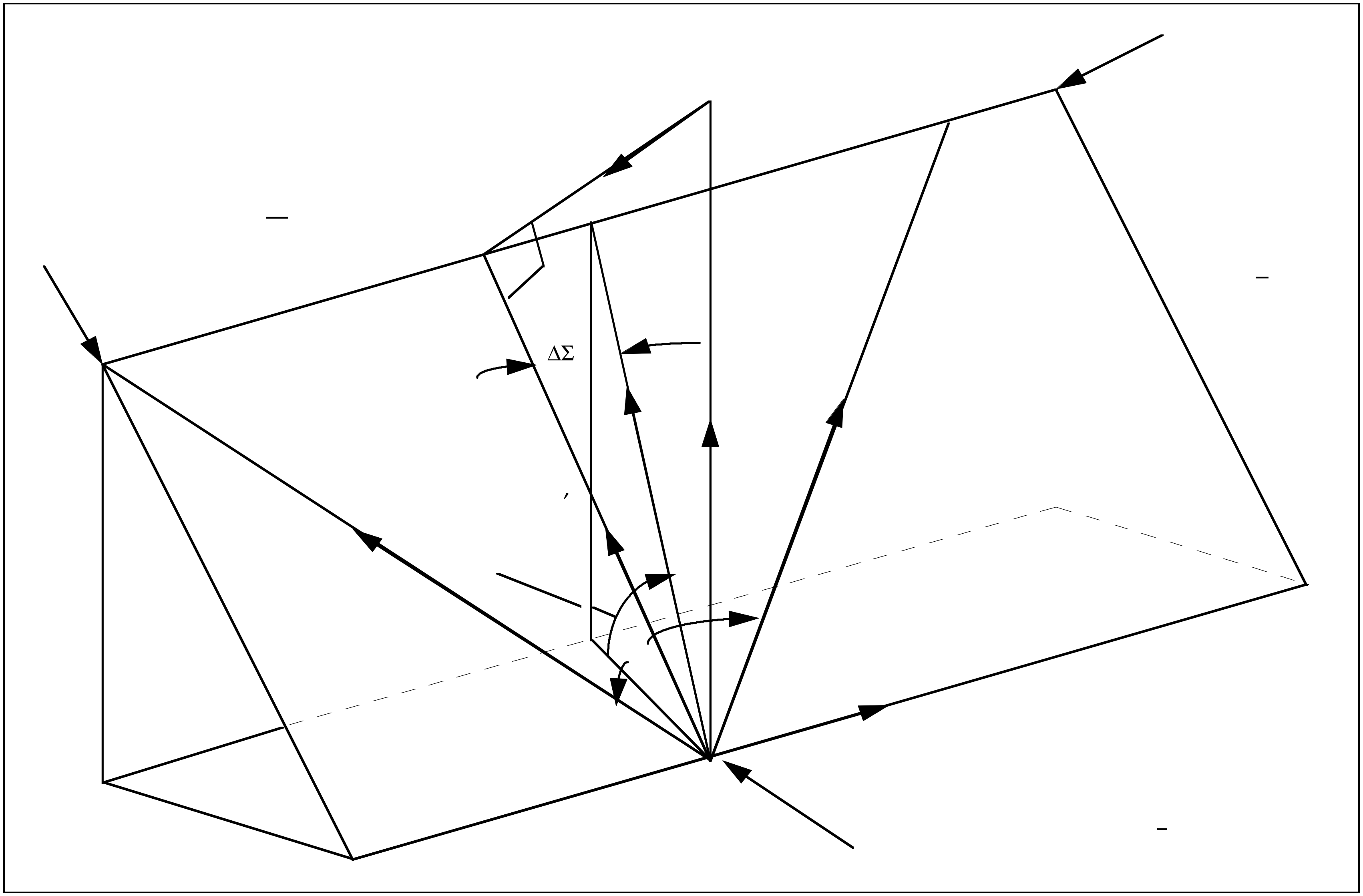

Figure 2.3-1 <u>Illustration of Angles involved in Stereo Imagery</u>

2.4 <u>Exploitation and Mapping Support Data (TBR)</u> The Exploitation and Mapping Support Data Extension will provide the necessary information to perform accurate geopositioning and mensuration. The Government has agreed to provide resolution as to form and content.

<u>Background</u>. This data extension may be executed in either of two methods:

1.) A Rational Polynomial Relating Position to Image Coordinates plus Associated Error Propogation
   - Candidate Models: RPC, Universal Math Model
   - Technique does require user to maintain proprietary sensor camera models
   - Issues with regard to accuracy, precision & error propogation to be addressed for mapping applications

2.) Ephemeris-based Geopositioning
   - Allows user to perform triangulation to determine location and associated errors
   - Requires use of rigorous projection models
   - Issues regarding:
     a.) Maintenance of Camera Models for each sensor platform
     b.) Proprietary Camera Models
     c.) User System Implementation requires extensive documentation of camera models and ephemeris reduction techniques for each satellite sensor.
     d.) Standard ephemeris data format for all commercial vehicles